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Marja Nikkilä
Iowa State University

Kenneth J. Stalder
Iowa State University

Benny E. Mote
Iowa State University

Jay Lampe
Swine Graphics enterprises

Bridget Thorn
Newsham Choice Genetics

See next page for additional authors

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Associations between Body and Leg Structure Traits in Gilts

Authors

Marja Nikkilä, Kenneth J. Stalder, Benny E. Mote, Jay Lampe, Bridget Thorn, Max F. Rothschild, Locke A. Karriker, and Timo Serenius

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Marja Nikkilä, graduate research assistant; Ken Stalder, associate professor; Benny Mote, graduate research assistant; Jay Lampe, Swine Graphics Enterprises; Bridget Thorn, Newsham Choice Genetics; Max Rothschild, distinguished professor; Anna Johnson, assistant professor; Locke Karriker, assistant professor; Timo Serenius, post doctoral research associate

Summary and Implications

The objective of this study was to investigate the genetic correlations between body and leg structure traits. The study was conducted at a commercial farm and involved 1449 females. Evaluated soundness traits consisted of six body structure traits, five leg structure traits per leg pair and overall leg action. Variance components were estimated using a multivariate repeatability animal model. The heritability estimates for body structure traits were low to moderate and for leg traits primarily low. The genetic correlations between body and leg structure traits were often favorable i.e. improvements in body structure were associated with improvements in leg structure. Furthermore, long and shallow body, high top line and steep hip structure were significantly associated with inferior leg action ($P \leq 0.05$). Therefore, in addition to selecting animals with superior feet and leg soundness, the body structure information could be utilized to enhance otherwise relatively slow genetic progress in leg structure and overall leg action.

Introduction

On the basis of PigCHAMP™ reports from the past 10 years, the average culling frequency of breeding herd females in the U.S. commercial swine herds has been 45% and the sow mortality rate has been almost 8%. Reproductive failure and leg problems are the primary culling reasons for young sows, thus genetic improvement in these traits is needed for increasing the sow productive lifetime and consequently the profitability for pork producers.

The objective of this study was to estimate the genetic correlations between body and leg structure traits for determining how these traits are associated with one another. The long term goal of this project has been to follow the surviving females at minimum through five parities, in order to identify which body composition and structural soundness traits have the greatest impact on sow longevity and would therefore be the most relevant ones for producers to consider during replacement gilt selection.

Materials and Methods

This study was conducted at a commercial farm and involved 1449 animals, roughly one third of them belonging to a grandparent line and the rest to a parent line. They were progeny of 58 known sires and 836 dams. Structural evaluation was carried out on 14 separate dates, and the gilts averaged 124 ± 11 kg body weight and 190 ± 7 days of age at the time of appraisal.

Evaluated structural soundness traits included six body structure traits (body length, depth and width, rib shape, top line and hip structure), five leg structure traits per leg pair (front legs: legs turned, buck knees, pastern posture, foot size and uneven toes; rear legs: legs turned, weak/upright legs, pastern posture, foot size and uneven toes) and overall leg action. All soundness traits were independently evaluated by two scorers using a nine-point scale. Top line, turned legs and weak/upright rear legs were each cut into two traits prior to analyses due to intermediate optimum.

Variance components were estimated with a multivariate repeatability animal model using the AI-REML algorithm in the DMU-package (Madsen and Jensen, 2004). The statistical model included genetic line, evaluation day and scorer as fixed effects, animal and its permanent environment as random effects and body weight at evaluation as a linear covariate.

Results and Discussion

The heritability estimates for body structure traits were low to moderate ($h^2 = 0.10 - 0.29$). Leg traits had primarily low heritability estimates ($h^2 = 0.02 - 0.31$). However, only the estimates for front legs turned in and front legs turned out ($h^2 = 0.02$ and 0.06 , respectively) did not differ significantly from zero ($P > 0.05$). Overall leg action had a heritability of 0.10.

The genetic correlations obtained between body and leg structure traits were often favorable, and several of them were also statistically significant ($P \leq 0.05$; Table 1). Longer and shallower body was associated with buck knees, upright front pasterns, outwardly turned rear legs and upright rear legs ($r_g = 0.41 - 0.73$). Also, narrower body was associated with buck knees and outwardly turned rear legs ($r_g = -0.54$ and -0.75 , respectively). Flat rib shape had significant correlations with buck knees and rear legs turned out ($r_g = 0.43$ and 0.53 , respectively). High top line was associated with upright front pasterns and outwardly turned rear legs ($r_g = 0.69$ and 0.80 , respectively), and steep hip structure with outwardly turned rear legs ($r_g = 0.58$). Furthermore, long and shallow body, high top line and steep hip structure were significantly associated with inferior leg action ($r_g = 0.44 - 0.71$).

As the heritabilities of body structure traits were primarily higher than the heritability estimates of leg structure traits, genetic improvement in body structure would likely be faster than what could be achieved in leg

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structure. The genetic correlations of body structure traits with leg structure traits and overall leg action were often favorable i.e. improvements in body structure were associated with improvements in leg structure and overall leg action. Therefore, relatively slow genetic progress in leg structure and overall leg action could be enhanced not only by selecting animals with superior feet and leg soundness, but also by utilizing information about body structure. Satisfactory leg structure and overall leg action are crucial

for increasing sow productive lifetime, since lameness is one of the primary causes of early culling.

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Table 1. Genetic correlations (\pm s.e.) between body and leg structure traits (correlations differing significantly from zero ($P \leq 0.05$) are in bold).

Leg traits ^b	Body structure traits ^a						
	BL	BD	BWD	RS	HTL	WTL	HS
FLTO	-0.04 \pm 0.32	-0.04 \pm 0.32	0.16 \pm 0.32	-0.00 \pm 0.31	-0.17 \pm 0.36	0.15 \pm 0.36	-0.31 \pm 0.32
FLTI	-0.07 \pm 0.53	-0.03 \pm 0.55	0.08 \pm 0.55	-0.18 \pm 0.50	-0.12 \pm 0.61	-0.05 \pm 0.58	-0.23 \pm 0.59
BK	0.60 \pm 0.19	0.73 \pm 0.16	-0.54 \pm 0.19	0.43 \pm 0.20	0.42 \pm 0.24	-0.17 \pm 0.28	0.36 \pm 0.23
FPP	0.44 \pm 0.17	0.42 \pm 0.17	-0.17 \pm 0.19	0.33 \pm 0.18	0.69 \pm 0.17	-0.37 \pm 0.24	0.35 \pm 0.19
FFS	0.23 \pm 0.23	0.06 \pm 0.24	-0.03 \pm 0.24	-0.03 \pm 0.23	0.46 \pm 0.25	-0.43 \pm 0.26	0.11 \pm 0.25
UFT	-0.05 \pm 0.27	0.01 \pm 0.27	-0.04 \pm 0.27	0.12 \pm 0.26	0.35 \pm 0.30	-0.22 \pm 0.31	0.11 \pm 0.28
RLTO	0.67 \pm 0.19	0.58 \pm 0.19	-0.75 \pm 0.17	0.53 \pm 0.20	0.80 \pm 0.26	-0.09 \pm 0.27	0.58 \pm 0.20
RLTI	-0.39 \pm 0.23	-0.18 \pm 0.24	0.62 \pm 0.20	-0.40 \pm 0.22	-0.47 \pm 0.27	0.18 \pm 0.28	-0.48 \pm 0.23
WRL	-0.20 \pm 0.24	-0.19 \pm 0.25	-0.06 \pm 0.25	0.07 \pm 0.26	0.32 \pm 0.30	-0.32 \pm 0.29	0.41 \pm 0.24
URL	0.42 \pm 0.19	0.41 \pm 0.21	-0.09 \pm 0.22	0.09 \pm 0.22	-0.04 \pm 0.28	0.29 \pm 0.25	-0.07 \pm 0.23
RPP	0.10 \pm 0.19	0.09 \pm 0.20	0.20 \pm 0.20	-0.16 \pm 0.21	-0.12 \pm 0.26	0.37 \pm 0.23	-0.03 \pm 0.21
RFS	0.08 \pm 0.24	0.02 \pm 0.26	-0.01 \pm 0.25	-0.05 \pm 0.25	-0.10 \pm 0.31	0.14 \pm 0.29	-0.19 \pm 0.26
URT	0.21 \pm 0.25	0.18 \pm 0.27	-0.12 \pm 0.25	0.42 \pm 0.25	0.25 \pm 0.33	-0.53 \pm 0.30	-0.08 \pm 0.26
OLA	0.48 \pm 0.21	0.44 \pm 0.22	-0.15 \pm 0.24	0.27 \pm 0.22	0.71 \pm 0.22	-0.24 \pm 0.28	0.66 \pm 0.21

^aBL = body length, BD = body depth, BWD = body width, RS = rib shape, HTL = high top line, WTL = weak top line, and HS = hip structure.

^bFLTO = front legs turned out, FLTI = front legs turned in, BK = buck knees, FPP = front pastern posture, FFS = front foot size, UFT = uneven front toes, RLTO = rear legs turned out, RLTI = rear legs turned in, WRL = weak rear legs, URL = upright rear legs, RPP = rear pastern posture, RFS = rear foot size, URT = uneven rear toes, and OLA = overall leg action.